

Gough's Cave 1 (Somerset, England): a study of the hand bones

ERIK TRINKAUS

Department of Anthropology, Campus Box 1114, Washington University, St. Louis, MO 63130, USA, and
U.M.R. 5809 du C.N.R.S., Laboratoire d'Anthropologie, Université de Bordeaux I, 33405 Talence, France

SYNOPSIS. The Gough's Cave 1 hand remains preserve five metacarpals and two proximal phalanges. Average metacarpal to arm length is similar to that of Holocene and Recent humans. Proximal phalanx length relative to metacarpal length is moderately short. Also of note is the general gracility of the hand, and the angular deviations of the metacarpo-phalangeal and proximal interphalangeal articulations away from a midline through the fourth ray.

INVENTORY

The hands of Gough's Cave 1 are represented by five metacarpals and two proximal phalanges (Fig.1). From the right hand are metacarpals 2 to 5, which are complete with minimal dorsal, radial and distal abrasion to the metacarpal 3. The left hand retains the complete metacarpal 4 plus the complete proximal phalanges 2 and 5; digit identification of the proximal phalanges is based their base morphologies (radial first dorsal interosseus tubercle on proximal phalanx 2 and ulnar *M. abductor digiti minimi* facet on proximal phalanx 5) and radial versus ulnar deviations of their heads. The osteometric measurements for these elements are in Tables 1 and 2.

In addition, midshaft cross-sectional geometric parameters (cross-sectional areas and second moments of area) are provided, even though comparative data are not currently available. The values were calculated from external diameters and cortical thicknesses determined from radiographs and then corrected for parallax enlargement, using standard ellipse formulae (Runestad *et al.*, 1993).

OVERALL HAND PROPORTIONS

Assessment of the overall proportions of the Gough's Cave 1 hand remains is limited by the dearth of comparative metrics for associated hand and arms remains, as well as the limited elements preserved for Gough's Cave 1.

It is nonetheless possible to compare the articular length of the metacarpal 3 to the summed humeral and radial articular lengths (averaging the right and left humeral articular lengths). The resultant ratio provides an index of 11.6. This value is close to the means of recent European and Amerindian samples [11.9 ± 0.5 , $N = 11$; 11.7 ± 0.5 , $N = 19$ (Trinkaus, 1983)]. Similarly, a ratio using the metacarpal 3 maximum length provides an index of 12.4 for Gough's Cave 1, which matches the highest of such indices for the Mesolithic remains from Arene Candide [AC 2: 11.6; AC 5: 12.4 (Paoli *et al.*, 1980)], Culoz 2 [12.0 (Genet-Varcin *et al.*, 1963)], and Le Peyrat 5 [11.9 (Patte, 1968)]. As with other Primates (Schultz, 1930) and members of the genus *Homo* (Trinkaus, 1983), the relative hand length of Gough's Cave 1 indicated by its metacarpal 3 length is similar across these European Holocene samples.

Proportions within the hand can be assessed by comparing proximal phalangeal lengths to metacarpal lengths for digits 2 and 5, even though this assumes near bilateral symmetry in metacarpal and phalangeal lengths given that Gough's Cave 1 preserves those

metacarpals on the right side and the phalanges on the left side.

The ratio of proximal phalanx 2 articular length to metacarpal 2 articular length gives an index of 56.7 for Gough's Cave 1, a value which is low but not exceptionally so compared to a recent British sample [59.8 ± 1.7 , $N = 38$ (Musgrave, 1970)]. The same index for the fifth digit gives a value of 58.0 for Gough's Cave 1, which is similarly relatively low compared to a recent British sample (61.2 ± 2.6 , $N = 38$). Alternatively, using maximum lengths, the Gough's Cave 1 phalanges and metacarpals can be compared to values for the Mesolithic Arene Candide 2 and 5 specimens (Paoli *et al.*, 1980). The resultant Gough's Cave 1 second and fifth ray indices are 58.2 and 62.0, both of which fall between the values for the Arene Candide specimens of 60.4 and 57.7 respectively for the second digit and 63.3 and 59.4 respectively for the fifth digit.

Consequently, the hand remains from Gough's Cave 1 exhibit metacarpal to arm length proportions similar to those of other European Holocene samples but, along with at least two other European Mesolithic specimens, possess moderately short proximal manual phalanges compared to a recent European sample.

METACARPAL MORPHOLOGY

The Gough's Cave 1 metacarpals are relatively large but appear variably gracile in their external surface morphology.

Most of the ridges for the dorsal interosseus muscles on the diaphyses are evident but do little more than provide an angulation between the dorsal plane of the diaphysis and the radial and ulnar surfaces. However, the radial dorsal ridge on the right metacarpal 2 for the first dorsal interosseus muscle is slightly more pronounced, forming a raised ridge from midshaft proximally to the radial side of the dorsal proximal epiphysis. The metacarpal 2 dorso-radial ridge is accompanied by a distinct concavity to the radial side of the metacarpal 2 diaphysis, which is bordered palmarly by a sharp crest extending from the radial head to the radial base but curving distinctly ulnarly near midshaft. A similar but less pronounced crest is evident on the distal half of the palmar metacarpal 3 diaphysis, and there is only a suggestion of similar relief on the palmar metacarpal 4 diaphysis.

There is no trace of the insertion of the *M. opponens digiti minimi* on the right metacarpal 5, and the ulnar tubercle on the base of the metacarpal 5 for the *M. extensor carpi ulnaris* tendon projects obliquely distally from the carpal articular surface and only moderately beyond the ulnar margin of that carpal articular surface. The last is reflected in the small difference (2.5mm) between the metacarpal 5 proximal maximum and articular breadths.



Fig. 1 Dorsal (above) and palmar (below) views of the Gough's Cave 1 metacarpals and proximal manual phalanges; $\times 0.9$.

This surface gracility is reflected in a metacarpal 3 robusticity index [midshaft height \times breadth]^{1/2} / articular length] of 13.1 for Gough's Cave 1. This value is below that of the Le Peyrat 5 right metacarpal 3 [15.0 (Patte, 1968)] and the mean of a modern British sample [14.4 ± 1.2 , $N = 38$ (Musgrave, 1970)].

The metacarpal 2 base has a large concave surface for the trapezoid bone, accompanied by facets for the trapezium and capitate at right angles to each other and close to 45° from the diaphyseal axis. The angle of 50° for the capitate facet is close to the mean of

a recent Euroamerican sample [$56.0^\circ \pm 9.3^\circ$, $N = 53$ (Niewoehner *et al.*, 1997)]. In conjunction with this oblique orientation of the Gough's Cave 1 metacarpal 2 / capitate articulation, Gough's Cave 1 possesses a large and projecting metacarpal 3 styloid process. The index of styloid projection (styloid projection vs. metacarpal 3 articular length) for Gough's Cave 1 is 6.6. This value is close to the mean for a recent Euroamerican sample of $7.4 [\pm 1.7, N = 33]$ (Niewoehner *et al.*, 1997)] and below that for the Le Peyrat 5 right metacarpal 3 [8.6 (Patte, 1968)]. The metacarpal 5 base combines

Table 1 Osteometrics of the Gough's Cave 1 metacarpals. Measurements in millimeters or degrees except for cross-sectional areas (mm²) and second moments of area (mm⁴).

Digit & side	2 right	3 right	4 right	4 left	5 right
Catalog number	1.1/15	1.1/14	1.1/13	1.1/22	1.1/12
Maximum length	71.0	68.3	58.9	59.3	55.0
Articular length ¹	67.5	64.1	57.6	57.9	54.3
Midshaft height	8.6	8.3	7.2	6.9	6.9
Midshaft breadth	9.1	8.5	6.6	6.7	8.3
Midshaft circumference	27.5	26.5	22.5	23.0	24.0
Midshaft total area	61.4	55.4	37.3	36.3	45.0
Midshaft cortical area	49.8	43.7	28.8	29.1	31.7
Midshaft medullary area	11.7	11.7	8.5	7.2	13.3
Midshaft AP 2nd moment of area	273.3	228.3	115.4	103.7	123.4
Midshaft ML 2nd moment of area	307.0	238.3	95.6	97.9	174.7
Midshaft polar moment of area	580.3	466.6	211.0	201.6	298.1
Proximal maximum height	17.3	16.7	11.5	11.4	11.1
Proximal maximum breadth	15.3	13.7	11.4	10.7	13.6
Proximal articular height	15.9	15.3	10.7	10.3	9.0
Proximal articular breadth	11.1	11.8	10.6	9.4	10.1
Distal height	13.6	13.4	11.6	11.3	11.5
Distal maximum breadth	14.8	13.6	12.1	12.1	11.6
Distal articular breadth	13.3	12.9	10.8	11.2	11.0
Trapezium articular breadth ²	4.3				
Trapezium angle ³	40°				
Capitate articular breadth ⁴	2.7				
Capitate angle ⁵	50°				
Styloid projection ⁶		4.2			
Hamate subtense ⁷	0.8				
MC 2 articular breadth ⁸		6.2			
MC 3 articular breadth	6.3		7.2	6.4	
MC 4 articular breadth		5.2			3.9
MC 5 articular breadth			5.3	5.0	

¹ Direct distance between the middle of the primary carpal articular facet and the most distal point on the head; ² Disto-radial to proximo-ulnar diameter of the facet for the trapezium on the metacarpal 2; ³ Angle, in the coronal plane of the metacarpal, between the plane of the trapezium facet and the diaphyseal axis of the metacarpal; ⁴ Maximum proximo-radial to disto-ulnar breadth of the facet for the capitate on the metacarpal 2; ⁵ Angle, in the coronal plane of the metacarpal, between the plane of the dorso-palmar middle of the capitate facet and the diaphyseal axis of the metacarpal 2; ⁶ Proximal projection of styloid process from the capitate surface (= Max.Len. – Art.Len.); ⁷ Subtense from the articular breadth of the proximal metacarpal 5 facet to the furthest point on the middle of the articular surface. A positive subtense indicates a radio-ulnarly concave facet; ⁸ 'MC # articular breadth' indicates the predominantly proximo-distal diameter of the facet for the indicated adjacent metacarpal base.

Table 2 Osteometrics of the Gough's Cave 1 manual proximal phalanges. Measurements in millimeters or degrees except for cross-sectional areas (mm²) and second moments of area (mm⁴).

Digit & side	2 left	5 left
Catalogue number	1.1/17	1.1/16
Maximum length	41.3	34.1
Articular length ¹	38.3	31.5
Midshaft height	6.2	5.8
Midshaft breadth	10.2	9.6
Midshaft circumference	27.0	26.0
Midshaft total area	49.6	43.7
Midshaft cortical area	43.1	37.1
Midshaft medullary area	6.6	6.6
Midshaft AP 2 nd moment of area	118.3	90.5
Midshaft ML 2 nd moment of area	310.4	243.0
Midshaft polar moment of area	428.7	333.5
Proximal maximum height	11.5	10.7
Proximal maximum breadth	16.0	14.3
Proximal articular height	9.5	8.5
Proximal articular breadth	11.8	10.9
Distal height	8.2	7.1
Distal maximum breadth	11.5	10.2
Distal articular breadth	10.7	9.6
Horizontal angle ²	-4°	13°
Vertical angle ³	1°	7°

¹ Minimum distance from the deepest point in the proximal base to the middle of the distal trochlea; ² Angle, in the coronal plane of the bone, between the tangents to the proximal and distal articulations. A positive angle indicates a relative ulnar deviation of the distal articulation; ³ Angle, in the parasagittal plane of the bone, between the tangent to the proximal articulation and the diaphyseal axis. A positive angle indicates a dorsal deviation of the proximal articular plane.

its small ulnar tubercle with a hamate surface with a distinct radio-ulnar concavity.

The heads of the metacarpals are of note only for their degrees of radial or ulnar deviation. Only the metacarpal 4 head is in line with its diaphysis. The metacarpal 5 head is strongly ulnarly directed, whereas the metacarpal 3 and especially metacarpal 2 heads are radially shifted.

PROXIMAL MANUAL PHALANGEAL MORPHOLOGY

The two preserved proximal manual phalanges, like the metacarpals, have weak to moderate muscle markings. There are clear ridges for the flexor tendon sheaths, but they project little from the palmar margins of the diaphyses. There are clear, oblique facets for the first dorsal interosseus muscle on the radial base of the proximal phalanx 2 and for *M. abductor digiti minimi* on the ulnar base of the proximal phalanx 5, but neither one is exceptional in its development.

Both bases are slightly dorsally oriented. At the same time, the head of the proximal phalanx 2 is moderately deviated radially and the head of the proximal phalanx 5 is strongly ulnarly deviated. Both of these angles combine with the respective radial and ulnar deviations of the associated metacarpals (even if those are evident only on the contralateral digits), to accentuate an apparent spread of the fingers, at least under conditions of habitual loading.

REFERENCES

- Genet-Varcin, E., Vilain, R., & Miquel, M. 1963. Une seconde sépulture mésolithique à Culoz (Ain). *Annales de Paléontologie (Vertébrés)*, Paris, **49**: 305–324.
- Musgrave, J.H. 1970. *An Anatomical Study of the Hands of Pleistocene and Recent Man*. Ph.D. Thesis, University of Cambridge.
- Niewoehner, W.A., Weaver, A.H. & Trinkaus, E. 1997. Neandertal capitate-metacarpal articular morphology. *American Journal of Physical Anthropology*, New York, **103**: 219–233.
- Paoli, G., Parenti, R. & Sergi, S. 1980. Gli scheletri mesolitici della Caverna delle Arene Candide (Liguria). *Memorie dell'Istituto Italiano di Paleontologia Umoma, Rome*, **3**: 33–154.
- Patte, E. 1968. L'homme et la femme de l'Azilien de Saint Rabier. *Mémoires du Muséum National d'Histoire Naturelle, Paris, Série C*, **19**: 1–56.
- Runestad, J.A., Ruff, C.B., Nieh, J.C., Thorington, R.W. & Teaford, M.F. 1993. Radiographic estimation of long bone cross-sectional geometric properties. *American Journal of Physical Anthropology*, New York, **90**: 207–213.
- Schultz, A.H. 1930. The skeleton of the trunk and limbs of higher Primates. *Human Biology, Detroit*, **2**: 303–438.
- Trinkaus, E. 1983. *The Shanidar Neandertals*. New York: Academic Press.